

## BACKGROUND OF THE INVENTION

**[0001]** The present invention generally relates to the field of manufacture and assembly of circuit boards. More specifically it relates to a tape guide for guiding a carrier tape in a component mounting machine, a tape magazine for receiving the tape guide, and a system including the tape guide and the tape magazine.

**[0002]** Generally, within the field of manufacture and assembly of circuit boards, electronic components are fed to a component mounting machine for mechanically and/or electrically mounting the components onto a circuit board. These surface mounted components are often delivered spaced apart along the length of a component tape, which consists of a lower carrier tape provided with compartments, one for each component, and an upper cover, or cover tape or protective tape. After positioning the electronic components in the corresponding compartments, the cover tape is attached to the carrier tape, and the component tape is wound on a component reel. The attachment of the cover tape to the carrier tape can, for instance, be performed by providing either the cover tape or the carrier tape with adhesive areas, or by fusing the cover tape to the carrier tape. Then, the component reel is transferred to a component mounting machine, which feeds a component to a certain predetermined picking position where it can be picked, or collected, by a pick-up head. WO 86/00778 shows a cassette magazine for a component mounting machine using the above described method.

**[0003]** According to the method conventionally used within the art, the loading of a component tape in a component mounting machine involves the following steps. Placing the component tape reel into the tape holder of a component mounting machine, or into a tape magazine of a component mounting machine; introducing the free end of the component tape into a feeding mechanism, provided in the machine or in the magazine, such that feeding pins engage corresponding holes provided in the component tape; separating, by hand, the end of the cover tape from the end of the carrier tape for a distance sufficient for the cover tape to be



efficiency of the manufacturing process and, hence, the overall costs. Additionally, when using a winding hub, or the like, for handling the cover tape, the required time for the loading process is further increased, and the unloading of the component tape includes the additional step of clearing the winding hub of the cover tape. Furthermore, there is high risk of a considerable component waste with the loading method according to prior art.

#### SUMMARY OF THE INVENTION

[0008] It is therefore an object of the present invention to provide a solution to the problem of complicated and time-consuming loading of a carrier tape into a component mounting machine.

[0009] A further object of the present invention is to reduce the high number of wasted components when unloading/reloading a carrier tape from/into a component mounting machine.

[0010] This and other objects are achieved according to the present invention by providing a tape guide, a tape magazine and a system having the features defined in the independent claims. Preferred embodiments are defined in the dependent claims.

[0011] For the purpose of clarity, the term lateral refers to the lateral direction of the carrier tape. The terms distal and proximal refers to the direction opposite to and along the feeding direction of the carrier tape, respectively.

[0012] The present invention is based on the insight of providing a tape guide, for guiding a carrier tape in a component mounting machine, said tape guide comprising exposure means for exposing the components at a picking position, wherein the exposure means comprises separating means for separating and lifting a lateral portion of the cover from the carrier tape, leaving the remaining portion of the cover at least partially attached to the carrier tape, and for bringing the lifted portion of the cover aside, with the ability to be releasably mounted such that the loading and/or unloading of a carrier tape into and from the tape guide can be performed away from the component mounting machine. Preferably, this is achieved according to the present invention by providing a tape guide with locking means for ready and quick attachment and detachment to interacting locking means in a component mounting machine, guiding means for guiding a carrier tape, and carrier tape retaining means for retaining the position of the carrier tape relative the tape guide.

[0013] By providing a tape guide with the ability to be loaded with a carrier tape away from a component mounting machine and to be subsequently loaded into the component mounting machine, a facilitated loading of the carrier tape into the machine, a reduced downtime of the machine, and, thereby, an improved time efficiency of the entire manufacturing process is achieved. This is due to the fact that the time-consuming process of loading the carrier tape into a component mounting machine, as described above with reference to known art, is reduced to simply placing a component tape reel into the tape holder of a component mounting machine, and mounting a tape guide into the machine. The rest of the loading process is performed beforehand and away from the component mounting machine. Thus, the downtime of the component mounting machine due to the loading of a carrier tape is limited to the actual time for placing a tape reel into the machine, and for loading a tape guide into the machine, which increases the time efficiency of the machine considerably.

[0014] The required features of the tape guide for enabling the loading of a carrier tape away from the machine and the subsequent loading of the tape guide, with the carrier tape, into the machine comprise locking means for ready and quick attachment and detachment of the tape guide into and from the machine, guiding means for correctly guiding the carrier tape into the machine, and carrier tape retaining means for retaining the position of the carrier tape relative the tape guide.

[0015] The locking means is provided for ready, quick and accurate mounting of the tape guide into the component mounting machine. The locking means of the tape guide is arranged for interaction with corresponding locking means provided on the component mounting machine, thus providing both a correct positioning and a secure mounting of the tape guide. Preferably, the locking means is in the form of resiliently biased snap-in locking means, e.g. in the form of a latch and a recess provided on the tape guide interacting with axles provided on the component mounting machine, or in the form of a catch and an axle, respectively, provided on the component mounting machine interacting with corresponding protrusion and recess provided on the tape guide. As realised by a person skilled in the art, various types of snap-in locking means, or other sorts of quick couplings, can be used for ready and quick attachment and detachment of the tape guide into and from a component mounting machine.

[0016] The guiding means is provided for guiding the carrier tape to the correct position within the component mounting machine, such that the components to be picked by a pick-up

**[0017]** According to the invention, the tape guide is provided with means for exposing a component to be picked at a picking position. This exposure means comprises separating means for separating and lifting a lateral portion of the cover from the carrier tape, leaving the remaining portion of the cover at least partially attached to the carrier tape, and for bringing the lifted portion of the cover aside such that the component to be picked can be exposed. A more detailed description of such separating means will follow below.

**[0019]** By arranging the separating means such that it covers a compartment, from the separating and lifting of the lateral portion of the cover until said compartment reaches the picking position, the number of components wasted is even further reduced. This is due to the fact that the compartments containing the exposed components are covered by the separating means both when the tape guide with the carrier tape is mounted in the component mounting machine, and when the tape guide with the carrier tape is located away from the machine. This is accomplished by the feature of the carrier tape retaining means, as described above. The carrier tape retaining means is provided for retaining the carrier tape such that the carrier tape is not accidentally displaced relative the tape guide, i.e. such that the tape guide can not move along the length of the carrier tape when the carrier tape has been loaded into the tape guide and before attachment of the tape guide into, or after detachment of the tape guide from, the component mounting machine, i.e. when the tape guide with the carrier tape is located away from the component machine. Thereby, following loading of the carrier tape into the tape guide, the tape guide is prevented from being accidentally removed from, or accidentally moved along the length of, the carrier tape. This ensures that when loading the carrier tape into the tape guide, the desired position of the carrier tape relative the component mounting machine, and its parts, can be chosen. The chosen position is then maintained until the carrier tape is released from the tape guide.

[0020] According to the most preferred embodiment of the invention, the carrier tape retaining means comprises a friction coupling, said friction coupling exerting a friction power upon the carrier tape sufficient to prevent the carrier tape from being accidentally displaced relative the tape guide. However, according to this embodiment, the friction power exerted by the coupling is insufficient to detrimentally affect the feeding action of the carrier tape into the component mounting machine, said feeding action being performed by feeding means provided in the component mounting machine. Therefore, there is no need for manipulating the friction coupling for enabling feeding of the carrier tape. Preferably, the friction coupling comprises a flexible support spring, provided in the tape guide underneath the carrier tape, and a counter support. The carrier tape is inserted between the support spring and counter support and is thereby held in place by the friction power. When removing the carrier tape from the tape guide, the carrier tape can simply be pulled out from the tape guide.

[0021] Additionally, using a flexible support spring for holding the carrier tape in place, brings the further advantage of stabilising the carrier tape, i.e. vibrations of the carrier tape when feeding the tape towards the picking position is greatly reduced, which reduces the risk of components being dislocated within their compartments. Furthermore, by using a flexible support spring for retaining the carrier tape, there will be no need for having movable parts in the tape guide, which facilitates the manufacturing of the tape guide and, hence, reduces production costs for producing the tape guide.

[0022] According to an embodiment, the exposure means constitutes part of the carrier tape retaining means. Preferably, the separating means is used for providing the counter support comprised in the friction coupling embodiment of the carrier tape retaining means described above. Thereby, no additional element is required as said counter support.

[0023] According to an embodiment of the present invention, the release of the carrier tape can either be performed manually, preferably only when the tape guide and the carrier tape are located away from the component mounting machine, or automatically, preferably when the tape guide with the carrier tape is mounted in the machine. According to said embodiment the carrier tape retaining means comprises a pivoted lever, preferably spring-loaded. The lever is at one end provided with a locking pin that, when in use, engages a hole of the carrier tape, thereby keeping the carrier tape at a position suitable for engagement by the feeding device. The lever is manually released during loading and unloading of the carrier tape into/from the tape guide, when the tape guide is located away from the component mounting machine, and is

automatically released when loading the tape guide, with or without a component tape, into the component mounting machine. The automatic release of the lever is achieved by the other end of the lever, opposite the end provided with the locking pin, being engaged by a part of the component mounting machine during the attachment of the tape guide into the machine.

[0024] As described above, the carrier tape retaining means ensures that the carrier tape is held in place relative the tape guide after removal from the component mounting machine, unless manually released. Thus, the tape guide may remain attached to the carrier tape between the unloading and reloading of the tape guide. Thereby, there will be no additional removal of the cover tape from the carrier tape when reloading a carrier tape into the machine, and, hence, there will be no waste of components due to reloading of a carrier tape that already has been partly used. This will reduce the overall costs for the manufacturing process.

[0025] According to an embodiment of the present invention, the body of the tape guide is formed by an elongated open-ended profile with opposing elongated walls, and a base connecting said elongated walls. The walls are provided with the above described guiding means for guiding the carrier tape. The base is provided with an opening for receiving feeding means, provided in the component mounting machine or in an intermediate device attached to the machine, e.g. a tape magazine, for engagement with the carrier tape by protrusion through the opening and engagement with feeding holes provided on the carrier tape. Thus, the tape guide does not comprise any feeding mechanisms at all, which significantly reduces the manufacturing costs for the tape guide.

[0026] After the carrier tape has been loaded into the tape guide, the tape guide can be connected to the tape reel, according to an embodiment of the invention, by arranging holding means on the tape guide for attachment of the tape guide to a tape reel. Thereby, the carrier tape reel can not be unrolled, and the tape reel can easily be stored together with the tape guide for quick mounting into a component mounting machine.

[0027] According to an embodiment of the invention, the holding means comprises a clip for attachment of the tape guide to a tape reel. According to an alternative embodiment, the holding means comprises a piece of Velcro® on the tape guide engaging a corresponding piece of Velcro® provided on the tape reel. As realised by a person skilled in the art, various types of holding means are contemplated without extending beyond the scope of the present invention.

[0028] According to an aspect of the present invention, a tape magazine is provided for reception of at least one tape guide according to the invention, the magazine being provided

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**[0030]** Further details and aspects of the invention will become apparent from the following detailed description of embodiments of the invention, reference being made to the accompanying drawings, wherein like reference numerals refer to similar parts throughout.

**[0031]** The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

**[0033]** Figure 2 is a top view illustrating the tape guide according to an embodiment of the invention;

**[0034]** Figure 3 is a cross sectional view of the tape guide according to a preferred embodiment of the invention;

**[0035]** Figure 4 is a cross sectional view of the tape guide shown according to an alternative embodiment of the invention;

**[0036]** Figure 5 is a schematic illustration of the loading of a carrier tape into a tape guide according to the invention;

**[0037]** Figures 6a, 6b, 7 and 8 are schematic side views of tape guides and tape magazines according to alternative embodiments of the invention; and



[illegible][illegible][illegible][illegible]

**[0042]** The second section 34 is provided on the body portion 33 of the first section 31, and extends vertically from, and essentially perpendicular to, the first section 31. According to this embodiment, said sections 31, 34 constitute portions of a single, integral device 30. As an alternative, said sections 31, 34 can be separable.

**[0044]** When feeding the carrier tape 2 in the feeding direction, as shown by the arrow in figure 2, the tip portion 32 separates and lifts the cover tape 4, at the lateral centre of the cover tape 4, from the carrier tape 2. The lateral extension of the body portion 33 to one side ensures that the corresponding side 4b of the cover tape 4 is separated from the carrier tape 2. The adhesive area 4a provided on the other side of the cover tape 4 is not affected by the separating means 30 and keeps that side of the cover tape 4 attached to the carrier tape 2. Following the separation of a portion of the cover tape 4 from the carrier tape 2, this portion is brought to an

upright position, at least at the picking position, by the second section 34. Thereby, the components 6 are completely exposed at the picking position.

[0045] The tape guide 10 is removably mounted to a component mounting machine, or a tape magazine, and can be removed together with the component tape 1 when unloading the component tape 1 from the component mounting machine. As can be seen in figure 3, the tape guide 10 is provided with a handle 11 for facilitating the attachment and detachment of the tape guide into and from the component mounting machine. In order to prevent the component tape 1 from being accidentally separated from the tape guide 10, when the tape guide 10 and the component tape 1 is not attached to a component mounting machine, or a tape magazine, the tape guide 10 is provided with carrier tape retaining means for preventing accidental displacement of the component tape 1 along the tape guide 10.

[0046] According to the most preferred embodiment of the invention, the retaining means comprises a flexible support spring 20 and a counter support, preferably in the form of the separating means 30 (not shown in figure 3), for insertion of a carrier tape therebetween. The support spring 21 exerts a pressure on the carrier tape 1, pressing the carrier tape against the counter support. Thereby, due to the friction between the carrier tape 1 and the retaining means, the carrier tape 1 is prevented from being accidentally displaced along the length of the tape guide 10, which means that the carrier tape 1 and the tape guide 10 remains attached when the tape guide 10 is detached from the component mounting machine. However, the friction power is insufficient to interfere with the feeding action provided by the feeding means. The support spring 20 also stabilises the carrier tape 1, such that vibrations are greatly reduced.

[0047] According to an alternative embodiment of the invention, the retaining means consists of a spring-loaded pivoted lever 20<sup>l</sup>, at one end provided with a locking pin 24, and a spring 23. When in use, the locking pin 24 engages a hole 5 of the carrier tape 2, thereby also keeping the carrier tape 2 at a position suitable for engagement by the feeding device 8. The lever 20<sup>l</sup> is manually released when loading and unloading the component tape 1 from the tape guide 10, when the tape guide 10 is located away from the component mounting machine, and is automatically released when loading the tape guide 10, with or without a component tape 1, into the component mounting machine. A recess 22 is provided in the retaining means 20<sup>l</sup> for enabling said automatic release.

[0048] Referring to figure 5, there is shown in schematic form the loading of a component tape 1 into a tape guide 10 provided with separating means 30 according to an embodiment of

-12-

the invention. A short portion of the end of the cover tape 4 has been separated from the carrier tape 2. The end of the carrier tape 2 is fed into the tape guide and brought past the distal end of the tip portion 32 of the separating means 30, enough to position said distal end in between the respective ends of the carrier tape 2 and the cover tape 4, and enough to allow a feeding mechanism to engage the carrier tape 2. The separated end of the cover tape 4 is then grasped and pulled in the feeding direction, thereby bringing the carrier tape 2 and the cover tape 4 past the distal end of the separating means 30.

[0049] Referring to figures 6a, 6b, 7 and 8, there is shown a tape reel 9, tape guides 10 and tape magazines 40 according to alternative embodiments of the invention. In figures 6a and 6b, there is shown a tape reel 9 provided with a component tape 1 that has already been loaded into the tape guide 10. The figures illustrate the quick loading of the tape guide 10 into a tape magazine 40 of a component mounting machine. The tape guide 10 according one embodiment is provided with locking elements in the form of a protrusion 25a and a recess 26 provided at opposite ends of the elongated tape guide 10. These locking elements interact with corresponding locking elements 45a, 46 in the form of a catch lock 45a and an axle 46 provided in the tape magazine 40. When loading the tape guide 10 into the magazine 40 the recess 26 first engages the axle 46, then the tape guide 10 is pivoted around the axle 46 such that the catch lock 45a goes into engagement with the protrusion 25a. Figure 6b shows the tape reel 9, the tape guide 10 and the tape magazine 40 after the tape guide 10 has been loaded into the magazine 40. For removal of the tape guide 10 from the tape magazine 40, the catch lock 45a has to be released.

[0050] Figure 7 shows an alternative embodiment similar to the embodiment of figures 6a and 6b wherein the catch lock 45a has been replaced by a resilient snap-in locking element 45b. The loading of the tape guide 10 into the magazine 40 is similar to the loading procedure described above. Other locking elements for the tape magazine 40 are contemplated within the scope of the invention, for instance a latch or some other form of resilient locking means, preferably in a snap-in arrangement.

[0051] In a further embodiment shown in figure 8 the locking elements provided in the tape magazine 40 are rigid, here in the form of separate, spaced apart axles 45c, 46. The locking elements of the tape guide are in the form of a spring-loaded latch 25c and a recess 26. The loading of the tape guide 10 into the magazine 40 is similar to the loading procedure described with reference to figures 6a, 6b and 7. Other locking elements for the tape guide are

contemplated within the scope of the invention, including both rigid and/or resiliently biased elements.

**[0052]** As can be seen in the figures 6a, 6b, 7 and 8 the tape magazine 40 is arranged for reception of the tape reel 9, as well as the tape guide 10. Preferably, a number of tape reels with corresponding tape guides can be received in a single tape magazine. The tape magazine is also arranged for reception of tape guides and tape reels of various widths. The widths of the tape reels and tape guides are, of course, adapted to the width of the component tape, which depends on the contained component.

**[0053]** According to an embodiment of the present invention, the tape guide 10 is provided with holding means for attaching the tape guide 10 to the tape reel 9. An example of this is shown in figure 9. Here the tape guide 10 is provided with a clip 27 that ensures that the tape guide 10 is not accidentally separated from the tape reel 9 after the component tape 1 has been loaded into the tape guide 10. Thereby, the tape reel 9 can not be unrolled, and the tape reel 9 can easily be stored together with the tape guide 10 for quick mounting into a component mounting machine. In an alternative embodiment the holding means is a piece of Velcro® (not shown) for engagement with a corresponding piece of Velcro® provided on the tape reel.

**[0054]** As apparent from this specification, the tape guide according to the invention can be directly mounted into a component mounting machine, or mounted into a tape magazine, either when the tape magazine already is loaded into a component mounting machine or before loading of the tape magazine into a component mounting machine.

**[0055]** The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.